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Python CIM Providers with PyWBEM

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MANAGEMENT DEVELOPERS CONFERENCE

Agenda

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- Design Goals
- Benefits
- Architecture
- Interface Details
- Demonstration
- References

Motivation

- Current provider interfaces (CIMOM-specific C++, CMPI, CIMPLE, ...) expose too many details of the WBEM operations.
- Current provider interfaces require too much boilerplate code.
- Providers required more build management effort than they should.
- Inspired by the ease and power of the PyWBEM client API.
- Leverage the dynamic nature of Python.

Design Goals

- Don't require provider writers to do anything that the provider interface could do for them.
- Ease of development.
- Ease of deployment.
- Leverage PyWBEM objects.
  - PyWBEM objects can be passed directly from PyWBEM client to python provider interface.
- Consistency with PyWBEM client API.
  - “Upcall” CIMOM handle matches pywbem.WBEMConnection.
- CIMOM neutral.
- Reduce operations.
- Reduce parameters.

Benefits

- Easy to debug.
- Provider writers can focus on solving the problem of instrumentation.
- Greatly reduced time to market.
- Less opportunity for error.

- Reduced LOC
  - Process Provider
    - C++: 3600
    - CMPI: 3338
    - Python: 800
  - File System Provider
    - C++: 2900
    - CMPI: 1383 (subset of classes/features)
    - CIMPLE: 1230 + 8650 generated
    - Python: 440

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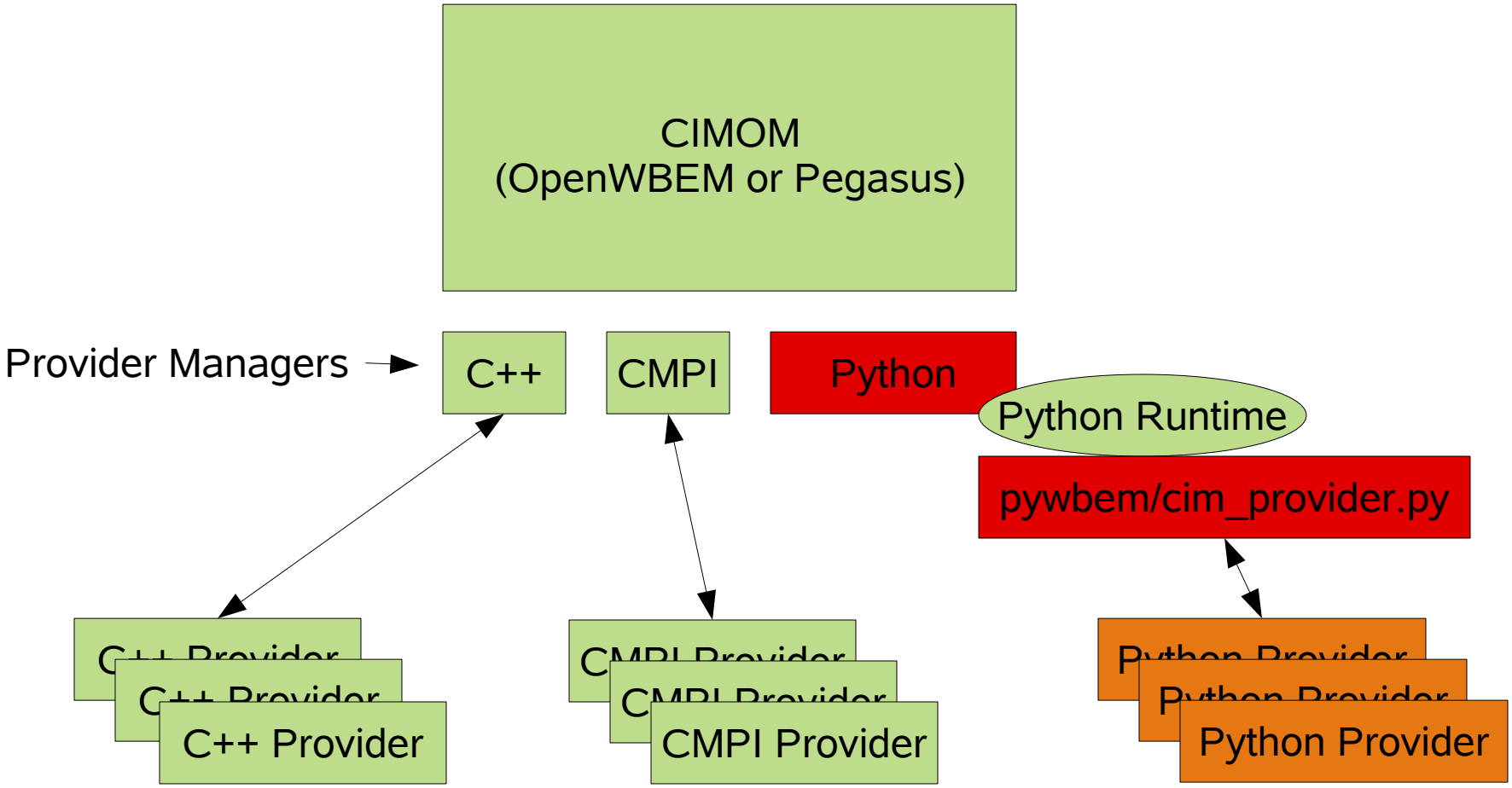
Architecture Diagram



Architecture

- Implemented as a provider manager for OpenWBEM and Pegasus.
- Converts native CIMOM objects to PyWBEM objects.
- Loads Python modules (the providers).
- Provides “upcall” CIMOM handle and other CIMOM services to providers through Python extensions.
- Python abstraction layer (cim_provider.py) maps WBEM operations from CIMOM to simplified, more friendly Python provider interface.

Interface Concepts

- Combine similar operations into one method.
  - EnumerateInstanceNames, EnumerateInstances --> enum_instances().
  - Associators, AssociatorNames, References, ReferenceNames --> references().
  - CreateInstance, ModifyInstance --> set_instance()
- Pass to the provider a “model” of the object(s) the provider should return.
  - The model is completed as much as possible by the interface.
  - The model conveys more information, such as PropertyList.
- Eliminate the need for providers to dispatch extrinsic methods.

'model' Parameter

- A pywbem.CIMInstance passed to instance and association methods.
- Attributes:
  - path – A pywbem.CIMInstanceName representing the ObjectPath of the instance.
  - classname – The name of the class.
  - properties – A case-insensitive dictionary containing the properties.
- Methods:
  - update_existing(<mapping>) -- Update the values of properties, iff the properties are already present in the instance.
- Behaves like a Python dictionary.
  - `model['propname']` returns/assigns the property **value**.
  - `model.properties['propname']` returns/assigns the pywbem.CIMProperty instance.

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'model' continued.

- Properties in the model correspond to the PropertyList parameter from the request, if present.
  - If a property is not present in the model, no need to compute and set the property value on the instance.
  - update_existing() method is useful for this.
- Providers can chose to ignore the PropertyList information, and set all of the properties.
  - The provider interface will filter for you.
  - This is configurable.
- In the case of get_instance, Key properties are set before calling into the provider.
- The provider should update the model, and return or yield it, depending on the method.

pywbem.CIMProvider Class

- Python base class for Instance, Association, and Method providers.
- A single subclass of pywbem.CIMProvider can service multiple CIM classes.
- A single Python provider module can contain multiple subclasses of pywbem.CIMProvider.

- CIMProvider methods:
  - __init__()
  - get_instance()
  - enum_instances()
  - set_instance()
  - delete_instance()
  - references()
  - Extrinsic methods.

get_instance

def get_instance(self, env, model, cim_class):

- Return the requested pywbem.CIMInstance.
- If the model does not correspond to a valid instance, raise pywbem.CIMError(pywbem.CIM_ERR_NOT_FOUND).
- Otherwise, set additional properties on the model, and return the model.
- Keyword arguments:
  - env – Provider environment
  - model – A template of the pywbem.CIMInstance to be returned. The key properties are set corresponding to the requested instance. If the request included a PropertyList, only properties in the PropertyList are present in the model.
  - cim_class – A pywbem.CIMClass representing the CIM class whose instance is requested.

enum_instances

def enum_instances(self, env, model, cim_class, keys_only):

- Python generator used to enumerate instances.
- For each instance, update the properties on the model, then yield the model.
- Keyword arguments:
  - env – Provider Environment.
  - model – A template of the pywbem.CIMInstances to be generated. Similar to get_instance.
  - keys_only – True if request was EnumerateInstanceNames. False if request was EnumerateInstances.
  - cim_class – A pywbem.CIMClass representing the CIM class whose instance is requested.

set_instance

def set_instance(self, env, instance, previous_instance, cim_class):

- Create or Modify an instance, or raise a pywbem.CIMError with an appropriate pywbem.CIM_ERR_*.
- Keyword arguments:
  - env – Provider environment.
  - instance – A pywbem.CIMInstance representing the new instance.
  - previous_instance – None if doing a CreateInstance, otherwise the pywbem.CIMInstance representing the old instance prior to modification.
  - cim_class – A pywbem.CIMClass representing the CIM class whose instance is requested.

delete_instance

def delete_instance(self, env, instance_name):

- Delete the specified instance, or raise a pywbem.CIM_Error with an appropriate pywbem.CIM_ERR_*.
- Keyword arguments:
  - env – Provider environment
  - instance_name – A pywbem.CIMInstanceName representing the instance to be deleted.

references

def references(self, env, object_name, model, assoc_class, result_class_name, role, result_role, keys_only):

- Handles all association operations (Associators, AssociatorNames, References, ReferenceNames).
- Python generator that yields instances of pywbem.CIMInstance representing CIM instances of the association class.
- Keyword arguments:
  - env – Provider environment
  - object_name – The target object
  - model – A template of the pywbem.CIMInstance to be returned.
  - result_class_name, role, result_role – See DSP0200.
  - keys_only – True if handling ReferenceNames.
  - assoc_class – A pywbem.CIMClass representing the CIM association class whose instance is requested.

Method Providers

- Providers don't need to dispatch methods.
- Just implement a python method matching the signature of the CIM method.
  - Method name is prefixed with “cim_method_”
  - Method IN parameters are prefixed with “param_”
- Return a 2-tuple containing the return value, and a dictionary with the OUT parameters.

Method Provider Example

- MOF:

```
uint32 RequestStateChange([IN] RequestedState,
  [IN(false), OUT] CIM_ConcreteJob REF Job,
  [IN] datetime TimeoutPeriod);
```

- Python:

```
def cim_method_requeststatechange(self, env,
        object_name, method, param_requestedstate,
        param_timeoutperiod):
```

  - object_name – A pywbem.CIMInstanceName or pywbem.CIMClassName indicating the target object.
  - method – A pywbem.CIMMethod representing the CIM method definition.
  - param_requestedstate and param_timeoutperiod are the IN parameters.
  - Return a 2-tuple containing the return value (pywbem.Uint32) and the dictionary {'job':pywbem.CIMInstanceName('CIM_ConcreteJob', ...)}

Module Functions

- Required:
  - get_providers(env)
    - Returns a dictionary mapping CIM class names to instaces of Python provider classes.
- Optional:
  - init(env)
    - Optional. First method called.
  - shutdown(env)
    - Called when the provider is unloaded.
  - can_unload(env)
    - Return True if the provider can be unloaded.
  - Indication related methods.
    - handle_indication, consume_indication, activate_filter, deactivate_filter.
    - Not covered in this presentation.

Provider Environment

- The first parameter passed to most functions or methods.
- Contains CIMOM services made available to providers.
- env.get_logger()
  - Return a logger object.
- env.get_cimom_handle()
  - Return an “upcall” CIMOM handle.
  - “Upcall” CIMOM handle interface resembles WBEM operations (DSP0200).
  - “Upcall” CIMOM handle interface is compatible with pywbem.WBEMConnection.

Provider Environment Example

```
logger = env.get_logger()
logger.log_debug('Debug Info')
ch = env.get_cimom_handle()
other_inst = ch.GetInstance(inst_path,
  LocalOnly=False, IncludeQualifiers=False,
  IncludeClassOrigin=False)
```

Code Generation

- Writes much of the provider for you.
- Generated code is specific to the CIM class being instrumented.
  - Intrinsic method stubs determined by the nature of the class.
  - Property names and types.
  - Extrinsic methods
    - Method names.
    - Parameter names and types.
    - Return types.
- Promotes consistent patterns across providers.
- Comments in the code teach how to write Python providers.
- Code generation is optional. (compare CIMPLE)
- Greatly reduces ramp-up time.
  - Just follow the instructions and fill in the blanks.

codegen

codegen(cim_class)

- cim_class is a pywbem.CIMClass
  - Make sure it has all of the properties, methods, and qualifiers.
- Returns a 2-tuple containing:
  - Syntactically correct Python provider module code, ready to run (though it won't do much).
  - Provider registration MOF.

Debugging

- Provider manager checks the timestamp of provider modules, and reloads if timestamp is newer.
  - Effortless to try the latest changes to provider code.
- Errors from providers, including syntax errors, are sent as stack traces to the client application.
- Debugging becomes quick and easy.
  - Nothing to rebuild.
  - Nothing to reinstall.

Demonstration

A live demo that includes:

- Generating provider module code using pywbem.codegen.
- Implementing the instance-related methods and extrinsic methods.
- Deploying and using the provider.
- Similar to the QuickStart Guide on the wiki.
  - http://pywbem.wiki.sourceforge.net/Provider+QuickStart

Summary

- The easiest way to write and maintain providers.
- Simplified interface.
- Easy debugging.
- Easy deployment.
- CIMOM neutral.

References

- http://pywbem.sourceforge.net/
- http://pywbem.wiki.sourceforge.net/
- http://pywbem.wiki.sourceforge.net/Provider+QuickStart
- http://omc.svn.sourceforge.net/viewvc/omc/pybase/trunk/
- http://omc.svn.sourceforge.net/viewvc/omc/pyprofiles/
- http://www.dmtf.org/standards/published_documents/DSP200.htm
- http://www.python.org/dev/peps/pep-0008/